BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Workshop Cost Estimates Based on EOSS, MORL, and BSM Costs - Case 710

DATE: July 25, 1968

FROM: A. E. Marks

ABSTRACT

An estimation of the development cost of a new early workshop accommodating 6 men for up to 2 years without resupply is made. Three previous contractor studies--Douglas EOSS[1], Douglas MORL[2], and the General Dynamics BSM[3] were used as a basis for this study. It is estimated that workshop development cost, including program management and ground support equipment, will be less than $600 million. The major cost item will be $210 million for subsystem development.

(NASA-CR-73560) WORKSHOP COST ESTIMATES BASED ON EOSS, MORL, AND BSM COSTS (Bellcomm, Inc.) 19 p

N79-72101

Unclas
00/15 11341

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MEMORANDUM FOR FILE

1.0 INTRODUCTION

To aid in NASA planning activities, an estimate of the cost of a 6 man workshop is made with three contractor studies being the basis: (1) Douglas Early Orbital Space Station (EOSS), NAS 8-21064, completed in November, 1967; (2) Douglas Manned Orbital Research Laboratory (MORL) NAS 1-3612, September, 1964; and (3) General Dynamics Basic Subsystem Module (BSM), NAS 9-6796, October, 1967. Of prime concern in this study is the development cost of the workshop only. Total program cost is not considered with such elements as experiments and logistics not evaluated.

The EOSS concept utilizes a ground-outfitted Saturn V launch with the S-IVB stage structure as the workshop. The baseline configuration consists of a Multiple Docking Airlock Module (MDAM), S-IVB Module including all subsystems required for crew habitation, experiments, and experiments accommodations. This configuration houses an average of 6 men and will operate for one year without resupply. A more detailed summary of the EOSS program is found in Reference 4. The philosophy behind the development of the station module was to use as many existing and near existing subsystems as possible. With the Saturn V launch vehicle, weight is not critical and this design philosophy could lead to a relatively cost effective station module.

The MORL is a 6 to 9 man workshop with the Saturn IB as the launch vehicle. The contemplated mission duration is 147 days without resupply. The station is 260 inches in diameter and 55 feet in length. Reference 5 contains a detailed summary of this program. This study was completed in 1964 and most subsystems contemplated were only in the initial development or in the conceptual stage. Design and test costs of these subsystems are therefore unusually high in light of current state-of-the-art.

The BSM study is an integrated engine-room module which incorporates power, environmental control/life support, and stability and control subsystems into a structural module to support any size or shape space station. The baseline systems are to support a 9 man crew. Expendables are provided, however, for a crew of six for a 2-year mission without resupply. Reference 6 contains a detailed summary of the BSM program. It is significant to note that the BSM is not a station in itself, but provides the subsystems necessary for a station. However, if used with a three man crew the BSM can accommodate the crew living quarters. The cost of such a BSM will therefore be somewhat lower than that of a comparable full space station.

2.0 DISCUSSION

Total program costs for the EOSS, MORL, and BSM are shown in Tables 1, 2, and 3, respectively. Of interest for this study is the station module cost in the EOSS program, the laboratory system cost of the MORL, and the BSM cost. The total EOSS program cost is shown in Table 1. The cost of interest is \$678 million for the station module. About \$11 million for mission support costs are subtracted resulting in about \$667 million station module cost. These costs are based on one flight article, one flight configuration prototype, and two equivalent articles for test.

The MORL Laboratory System cost is \$870 million (Table 2). The baseline cost is estimated at \$796 million since \$51 million was included for launch vehicles and \$23 million for mission and launch support. These costs are for development of three sets of hardware and one year of flight operations.

The BSM program cost is shown in detail in Table 3. and is \$313.4 million. This cost is for development of one flight article and one prototype, and are for a one year no resupply station (expendables for a 6 man crew for 2 years).

Table 4 summarizes the major station development cost elements of the three studies. Obvious cost discrepancies can be noted from this table. A factor of three variation in subsystem costs exists. While the MORL and BSM systems integration and test costs are comparable, the EOSS is quite low. The BSM ground support equipment costs are very low as are the program management costs. These discrepancies will be discussed individually.

2.1 Subsystems

Major subsystem costs broken down into design, manufacturing and testing are shown in Table 5. The recurring costs are for development of the first unit. The structure costs of the three programs are fairly consistent. The cost of the EOSS structure, which weighs about 40,000 pounds, is only about \$19 million. This is due to the fact that the basic structure is the S-IVB and there is therefore small design and test costs.

The MORL structure, weighing over 8800 pounds, costs $30 million with $19 million being non-recurring. The 3350 pound BSM structure costs $17 million of which $15.5 million is non-recurring. The manufacturing costs of the BSM seem quite low, however, and it is estimated that a space station structure to house 6 men for at least a year can be built for about $25 million.

There is a marked discrepancy in the stabilization and control system costs. All three stations make use of control moment gyros (CMG's), yet the MORL and BSM have $35 to $40 million in design and testing. Since these devices are designed and currently under testing, the EOSS design and test costs of around $10 million seems much more reasonable. The MORL study did not have CMG's at the current state-of-the-art (S.O.A.) and hence the high development cost is explainable. It is estimated that a total cost of about $20 million will be sufficient for stabilization and control systems.

The electrical power system (EPS) costs are fairly consistent. All stations employ solar panels with batteries as back-up and emergency. MORL costs are quire high but this is again due to the then current S.O.A. of this system at the time the study was conducted. The EOSS EPS draws 5.4 KW and costs about $30 million. The BSM draws 10 KW and costs about $45 million. The latter cost and power level seems reasonable and is used in the baseline station cost.

The cost of the ECS and LSS for the EOSS is relatively low since existing systems were used with the weight penalty accepted. The MORL and BSM use advanced systems (Sabatier, urine H_2O recovery, etc.) and therefore have higher costs. Most of the BSM EC/LS system costs are in testing to achieve a desired two year lifetime. It is estimated that these subsystems will cost about $70 million.

The most difficult subsystem cost to estimate from the reference studies is communications and data management. The EOSS, using continuously operating low rate-type equipment, estimates this subsystem cost to be over $23 million. The MORL, using high rate periodic-type systems, estimates a cost of over $74 million of which an unusually high $40 million is for manufacturing. The BSM does not include communications and data management in its cost. A cost of about $40 to $50 million is felt adequate to develop a satisfactory communications and data management system.

The estimated total subsystems development and first unit production costs are shown in Table 6. It is felt that a new space station to house 6 men for at least one year will have subsystems that can be developed for about $210 million.

2.2 System Integration

System integration costs including testing are estimated at $104 million for the EOSS, $90 million for the MORL, and $84 million for the BSM. These costs are all fairly consistent and $90 million is assumed as reasonable for the baseline station.

2.3 Ground Support Equipment

The GSE to support the station module is estimated at $139 million for the EOSS, $114 million for the MORL, and only $17 million for the BSM. The reason for the low GSE cost for the BSM may be the uncertainty of the mission or station type to which it will be attached.

Many diverse items are included in the GSE and Table 7 delineates these items for the MORL. The GSE equipment is grouped in categories of Checkout Equipment, Service Equipment, Auxiliary Equipment, and Handling Equipment. Also indicated in Table 7 is the quantity of pieces to be procured and the location where they will be used. The costs of engineering design and development personnel are not included. This table is meant to be indicative of the types of equipment needed -- realizing specific hardware items are dependent on the station type.

The GSE costs for a new workshop is estimated at about $100 million. This is felt reasonable in light of the three reference studies.

2.4 Program Management

Another discrepancy in the BSM results is the low program management cost. Whereas the EOSS and MORL have about $80 million and $104 million program management costs, respectively, the BSM only shows a little over $14 million. The EOSS and MORL costs include 10% for NASA management and technical direction. Program management costs are obviously going to exceed $14 million for a workshop development, and this cost is estimated at $80 million.

2.5 Miscellaneous Items

Spares are estimated for the MORL and BSM at about $7 million per station. No spares allotment is included in the EOSS costs. Spares for the baseline station are therefore estimated at $7 million.

There are a number of station associated hardware items included in the EOSS and MORL costs. These items include dynamic, structural, and flame test articles, as well as mockups and functional prototypes. These types of equipment are estimated to cost $94 million for the EOSS and $80 million for the MORL. No allocation for these items was made in the BSM study. It is therefore estimated that about $80 million in associated hardware items will be necessary for a new space station development.

3.0 CONCLUSIONS

The estimated cost of the development of a new 6 man workshop with a one to two year no-resupply lifetime is under $600 million, Table 6. Of these costs, over $200 million is in subsystem development with almost $100 million each in system integration and test, GSE, and program management. This cost is preliminary and somewhat arbitrary but represents a reasonable estimate based on the EOSS, MORL, and BSM studies.

A question of recurring interest is the savings associated with using current subsystem capability vs. improved subsystem capability. Comparison of the EOSS subsystems cost to the cost constructed in this memo shows a difference of $105 million against a total workshop cost of $567 million. This difference could quickly disappear, however, when one considers the launch vehicles. The EOSS must be launched with a Saturn V, while the MORL, BSM, or new workshop could be launched with a Saturn IB or possibly Titan-IIIM.

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Attachments
Tables 1-6
References

Table 1

EOSS PROGRAM ELEMENT COSTS

Element	Cost ($ million)
Station module[1]	678
Experiments[2]	1,529
Logistic system[3]	985
Facilities	58
System GSE	18
Flight crew system	405
Total	3,673

1. Costs are for one prototype and one flight article.
2. Cost includes two sets of hardware and experiment accommodations and integration.
3. Includes one manning flight, four logistic flights, and two spares.
4. Includes program management and mission support.

EOSS NONRECURRING AND RECURRING PROGRAM COSTS

	Cost* ($millions)		
Program Element	Nonrecurring	Recurring	Total
MDAM	70.6	22.2	92.8
S-IVB module	402.1	59.7	461.8
Experiments	614.0	651.0	1,265.0
Logistic System	0.6	914.5	915.1
Facilities	49.0	---	49.0
System GSE	10.6	4.7	15.3
Flight Crew System	225.2	113.9	339.1
Total	1,372.1	1,766.0	3,138.1

*Costs do not include program management or mission support.

TABLE 2

TOTAL MORL PROGRAM COST
($ millions)

Laboratory System		$ 870.07 (796)*
Logistics System		831.27
Mission Operations		115.44
Flight Crew Training		267.80
Facilities		77.86
Program Management		335.75
	TOTAL	$2498.19

COST OF AN OPERATIONAL YEAR

($ millions)

Logistics Systems		$ 250.5
Operational Support		5.2
Operational Spares		2.8
Mission Operations		104.0
Flight Crew Training		20.0
Program Management		42.5
	TOTAL	$ 425.0

* $870 million includes one launch vehicle @ $51 million and mission and launch support of $23 million.

Table 3 Cost Detail of Independently Developed '73 BSM

Subsystem or Subdivision	$ Thousands								
	Development Engineering	Initial Tooling	Test	Test Hardware	Total Non-Recurring	Sustaining Engineering	Manufacturing and Checkout	Materials and Subcontract	Total Recurring (per module)
Structure and Radiators	2,270	760	4,950	7,550	15,530	300	2,240	260	2,800
EC/LSS	11,830	1,020	7,340	40,820	61,010	1,090	6,250	40	7,380
Data Mgt. and Crew Eqpt.	400	40	560	1,480	2,480	60	120	550	730
Spacecraft Control	24,750	20	5,720	11,980	42,470	280	100	3,380	3,760
Electric Power	3,000	890	3,000	25,560	32,450	500	2,290	9,490	12,280
Integration and Management	10,700		800		11,500	2,910			2,910
Installation and Checkout	3,310	80	3,040	600	7,030	1,000	1,200	20	2,220
On-Board Spares						80	820	750	1,650
Combined Systems Test	2,500		4,500	76,830	83,830				
Subtotal	58,760	2,810	29,910	164,820	256,300	6,220	13,020	14,490	33,730
GSE	16,800				16,800				
Factory and Checkout Spares						340	3,380	3,040	6,760
Training	950				950	680			680
Launch Support	300				300	960			960
Mission Operations	300				300	4,060			4,060
Resupply Spares									
Total	77,110	2,810	29,910	164,820	274,650	12,260	16,400	17,530	46,190

TABLE 4

SPACE STATION COST COMPARISON

	EOSS		MORL		BSM	
	N.R.	R.	N.R.	R.	N.R.	R.
Subsystems	98.0	42.8	305.3	81.8	160.9	30.8
MDAM	70.6	22.2				
System Integration	104.0	2.5	89.6		83.8	
GSE	121.0	17.0	114.2		16.8	
Program Management	80.2	14.7	104.3		11.5	2.9
Spares			22.0			6.7
Associated Hardware Items*	93.8		78.7			
	567.6	99.2			273.0	40.4
	666.8		795.9		313.4	

*These items include dynamics test articles, static test articles, flame test articles, mockups, etc.

TABLE 5

SUBSYSTEM DEVELOPMENT COSTS
(FIRST ARTICLE)

	EOSS N.R.	EOSS R.	EOSS TOTAL	MORL N.R.	MORL R.	MORL TOTAL	BSM N.R.	BSM R.	BSM TOTAL
Structures	16.0	2.8	18.8	19.2	10.5	29.7	15.5	1.4	16.9
Design	1.5		1.5	9.1		9.1	2.3	.2	2.5
Manufacturing	11.3	2.6	13.9	10.1	6.9	17.0	.8	1.2	2.0
Test	3.2	.2	3.4		3.6	3.6	12.4		12.4
S.C.S.	14.2	1.5	15.7	33.7	3.9	37.6	42.5	1.9	44.4
Design	5.8		5.8	20.4		20.4	24.8		24.8
Manufacturing	4.0	1.2	5.2	13.4	.3	13.6		1.9	1.9
Test	4.4	.3	4.7		3.6	3.6	17.7		17.7
E.P.S.	21.8	1.9	23.7	54.0	4.9	58.9	32.5	6.1	38.6
Design	13.7		13.7	34.7		34.7	3.0	.2	3.2
Manufacturing	7.1	1.8	8.9	16.9	2.6	19.5	.9	5.9	6.8
Test	1.0	.1	1.1	2.4	2.3	4.7	28.6		28.6
EC/LS	21.7	2.6	24.3	41.6	4.7	46.4	61.0	3.7	64.7
Design	6.4		6.4	34.0		34.0	11.8	.6	12.4
Manufacturing	6.4	1.9	8.3	7.0	.7	7.7	1.0	3.1	4.1
Test	8.9	.7	9.6	.6	4.0	4.6	48.2		48.2
Communication and Data Management	17.6	5.5	23.1	69.7	4.4	74.1			
Design	11.3		11.3	39.8		39.8			
Manufacturing	4.9	5.1	10.0	29.6	.2	29.8			
Test	1.4	.4	1.8	.2	4.1	4.3			

TABLE 6

BASELINE STATION MODULE COST

NOMINAL 6 MAN CREW

1 TO 2 YEAR MISSION

1ST. ARTICLE COST

	COST ($MILLIONS)	
SUBSYSTEMS	210	
STRUCTURE		25
SCS		20
EPS		45
EC/LS		70
COMMUNICATIONS AND DATA MANAGEMENT		50
SYSTEMS INTEGRATION AND TESTING	90	
GSE	100	
PROGRAM MANAGEMENT	80	
SPARES	7	
ASSOCIATED HARDWARE ITEMS	80	
	567	

TABLE 7

TYPICAL GSE HARDWARE LIST

MORL CHECKOUT EQUIPMENT (page 1 of 6)

Item No.	Similarity No.	Item	Factory		Cape Kennedy		Houston		Total Cost M of $
			No. of Units	Cost M of $	No. of Units	Cost M of $	No. of Units	Cost M of $	
1	DSV-4B 110	Electrical Power Component Test Set	2	0.2275	1	0.11375	1	0.11375	0.455
2	DSV-4B 104 & 109	Electrical Component Test Set	2	0.215	1	0.1075	1	0.1075	0.430
3	-----	Inertial Component Test Set	2	0.390	1	0.195	1	0.195	0.780
4	DSV-4B 115, 102 & 252	R. F. Component Test Set	2	1.8125	1	0.90625	1	0.90625	3.625
5	DSV-4B 134	Ground Power Equipment	4	0.2222	4	0.2222	1	0.0556	0.500
6	-----	EC/LS System Component Test Set	1	0.215	1	0.215	0	0	0.430
7	-----	EC/LS Load Simulation Equipment	1	0.027	1	0.027	0	0	0.054
8	-----	Space Suit Simulation Test Equipment	1	0.0875	1	0.0875	0	0	0.175
9	-----	Docking and Storage Simulator	1	0.025	1	0.025	0	0	0.050
10	-----	Cable Installation and Continuity Tester	1	0.075	0	0	0	0	0.075
11	-----	Laboratory Simulator for GSE Verification	1	0.400	0	0	0	0	0.400
12	DSV-4B 132	GSE Test Set	2	0.9633	1	0.4817	0	0	1.445
13	-----	Solar Simulator	1	0.200	1	0.200	0	0	0.400
14	-----	Horizon Simulator	1	0.300	1	0.300	0	0	0.600

Table 7 (page 2 of 6)

Item No.	Similarity No.	Item	Factory		Cape Kennedy		Houston		Total Cost M of $
			No. of Units	Cost M of $	No. of Units	Cost M of $	No. of Units	Cost M of $	
15	DSV-4B 196, 114	Hyrotechnics Test Set	2	0.3525	2	0.3525	0	0	0.705
16	-----	Leak Check Test Equipment	1	0.0515	1	0.0515	0	0	0.103
17	-----	Command Transmitter	2	0.0506	1	0.0254	0	0	0.076
18	-----	Antenna System Test Equipment	1	0.090	0	0	0	0	0.090
19	DSV-4B 130	Response Signal Conditioner Spacecraft (carry on)	2	1.3866	1	0.6934	0	0	2.080
20	DSV-4B 146	Patch Panel (carry on)	2	0.2566	1	0.1284	0	0	0.385
21	DSV-4B 30	Response Signal Conditioner GSE	2	1.040	1	0.520	0	0	1.560
22	DSV-4B 146	Patch Panel GSE	2	0.340	1	0.170	0	0	0.510
23	DSV-4B 118	Data Interfacing and Sequencing Unit (carry on)	2	0.2733	1	0.1367	0	0	0.410
24	DSV-4B 130	Stimulus Signal Conditioner Spacecraft	2	1.040	1	0.520	0	0	1.560
25	DSV-4B	Stimulus Signal Conditioner GSE (carry on)	2	1.040	1	0.520	0	0	1.560
26	-----	Power Rack, GSE (carry on)	2	0.0133	1	0.0067	0	0	0.020
27	-----	Cryogenic Test and Bench Maintenance	1	0.410	1	0.410	0	0	0.820
28	-----	Pressure and Flow Calibration Equipment	1	0.1025	1	0.1025	0	0	0.205

Table 7 (page 3 of 6)

Item No.	Similarity No.	Item	Factory		Cape Kennedy		Houston		Total Cost M of $
			No. of Units	Cost M of $	No. of Units	Cost M of $	No. of Units	Cost M of $	
29	-----	ACE	2	12.000	1	6.000	0	0	18.000
30	-----	Solar Panel Checkout Equipment	1	0.400	1	0.400	0	0	0.800
31	DSV-4B 101	Battery Test Set	1	0.1375	1	0.1375	0	0	0.275
32	DSV-4B 100	Battery Charger Equipment	1	0.030	1	0.030	0	0	0.060
33	DSV-4B 234	Static Firing Propulsion Control Console	1	0.515	1	0.515	0	0	1.030
34	DSV-4B 321	Pneumatic Cold Gas Test Equipment	2	0.113	1	0.057	0	0	0.170
35	-----	Ferry Craft Electrical Simulator	2	0.1013	1	0.507	0	0	0.152
36	-----	Cargo Module Electrical Simulator	2	0.0506	1	0.0254	0	0	0.076
37	-----	Booster Electrical Simulator	2	0.020	1	0.010	0	0	0.030
38	-----	Propulsion System Component Test Equipment	1	0.205	1	0.205	0	0	0.410
39	DSV-4B 140	Cable Installation	3	0.4283	5	0.7139	1	0.1428	1.285
	MORL	Checkout Equipment Subtotal		25.6076		14.6625		1.5209	41.791
		MORL SERVICE EQUIPMENT							
1	DM-20 97	Thermoconditioning Equipment	2	0.468	2	0.468	1	0.234	1.170
2	DM-20 323	Fuel Servicing Equipment	1	0.1075	1	0.1075	0	0	0.215

Table 7 (page 4 of 6)

Item No.	Similarity No.	Item	Factory No. of Units	Factory Cost M of $	Cape Kennedy No. of Units	Cape Kennedy Cost M of $	Houston No. of Units	Houston Cost M of $	Total Cost M of $
3	DM-20 322	Oxidizer Servicing Equipment	1	0.1125	1	0.1125	0	0	0.225
4	DM-20 326	Vacuum Cleaning Equipment	1	0.3227	1	0.3227	0	0	0.645
5	DM-20 326	Cooling System Servicing Equipment	1	0.300	1	0.300	0	0	0.600
6	DM-20 322	Heating System Servicing Equipment	1	0.1135	1	0.1135	0	0	0.227
7	-----	Water Servicing Equipment	1	0.057	1	0.057	0	0	0.114
8	-----	High Pressure O_2 Servicing Equipment	1	0.080	2	0.160	0	0	0.240
9	-----	High Pressure N_2 Servicing Equipment	1	0.080	2	0.160	0	0	0.240
10	-----	Cryogenic O_2 Servicing Equipment	1	0.1383	2	0.2767	0	0	0.415
11	-----	Cryogenic N_2 Servicing Equipment	1	0.1383	2	0.2767	0	0	0.415
12	-----	Propulsion System Remote Control	1	0.3483	2	0.6967	0	0	1.045
		Subtotal		2.2661		3.0513		0.234	5.551
		MORL AUXILIARY EQUIPMENT							
1	DSV-4B 345	Weight and Balance Equipment	1	0.066	1	0.066	0	0	0.132
2	DSV-4B	Propulsion Engine Module Alignment Test Equipment	1	0.007	1	0.007	0		0.014

Table 7 (page 5 of 6)

Item No.	Similarity No.	Item	Factory		Cape Kennedy		Houston		Total Cost M of $
			No. of Units	Cost M of $	No. of Units	Cost M of $	No. of Units	Cost M of $	
3	DSV-4B 304	Protective Cover Kit	1	0.0445	1	0.0445	0	0	0.089
4	DSV-4B 313	Umbilical Kit Checkout	3	0.3557	4	0.4743	0	0	0.830
5	DSV-4B 315	Umbilical Kit Launch	0	0	1	0.220	0	0	0.220
6	-----	Inverted Checkout Support Fixture	2	0.2583	3	0.3875	1	0.1292	0.775
7	-----	MORL to Gemini Capsule Mating Fixture	1	0.025	1	0.025	0	0	0.050
8	-----	Solar Panel Support Fixture	1	0.025	1	0.025	0	0	0.050
9	DM-20 Elgin C.R.	Clean Room Checkout	0	0	2	0.050	0	0	0.050
10	DM-20 Elgin C.R.	Clean Room Launcher	0	0	1	0.025	0	0	0.025
11	-----	Space Chamber Support Fixture	1	0.010	1	0.010	0	0	0.020
12	-----	Access Kit Interior MORL Horizontal	2	0.107	1	0.053	0	0	0.160
13	-----	Access Kit Interior MORL Vertical	0	0	1	0.042	0	0	0.042
14	-----	Access Kit Interior MORL Inverted	2	0.0328	2	0.0328	1	0.0164	0.082
15	-----	Attitude Control Module	1	0.020	1	0.020	0	0	0.040
16	DSV-4B 340	MORL to SIV-B Alignment Kit	0	0	1	0.030	0	0	0.030

Table 7 (page 6 of 6)

Item No.	Similarity No.	Item	Factory No. of Units	Factory Cost M of $	Cape Kennedy No. of Units	Cape Kennedy Cost M of $	Houston No. of Units	Houston Cost M of $	Total Cost M of $
17	DSV-4B 305	Special Tool Kit	1	0.0055	1	0.0055	0	0	0.011
18	-----	Work Stands	2	0.050	4	0.100	1	0.025	0.175
		Subtotal		1.0068		1.6176		0.1706	2.795
		MORL HANDLING EQUIPMENT							
1	-----	Transporter - MORL	2	0.300	2	0.300	0	0	0.600
2	DSV-4B 301	Cradles Kit	2	0.140	2	0.140	1	0.070	0.350
3	DSV-4B 302	Handling Kit	2	0.110	2	0.110	1	0.055	0.275
4	DSV-4B 303	Hoisting Kit	1	0.0446	1	0.0446	1	0.0446	0.134
5	DSV-4B 307	Handling Kit Nose Cone	1	0.0446	1	0.0446	1	0.0446	0.134
6	DSV-4B 306	Small Arms Protective	1	0.032	1	0.032	1	0.032	0.096
				0.671		0.671		0.247	1.589
				29.5515		20.0024		2.1725	51.726
							a. +10% for installation		5.173
							b. +20% for growth		10.346
		Total - MORL GSE							$67.245

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5. W. H. Eilertson, Summary of MORL for EMSF Program Planning, Bellcomm letter to C. L. Davis, July 8, 1968.

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From: A. E. Marks

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